# Science standards Grade 12

## Advanced level

## Scientific enquiry

By the end of Grade 12, students identify, develop and make predictions related to a clearly focused research question. They control variables, work as a team and use appropriate equipment and materials. They evaluate experimental design, identify weaknesses and develop realistic strategies for improvement. They work in an ethical manner. They understand the historical development of major scientific ideas, know scientific work is affected by its context and are aware of the power and limitations of science in addressing questions. They understand how scientific ideas develop over time and recognise the importance of refutation. They record and process raw data appropriately and draw valid conclusions, allowing for errors and uncertainties. They handle equipment competently with due regard for safety. They follow instructions accurately but are able to adapt to unforeseen circumstances.

### Students should:

#### 1 Use methods of scientific investigation

1.1 Identify and develop a clearly focused research question.

Compare by experimentation the relative energy values of fat and carbohydrate.

Determine the rate of transpiration of different plants.

Use chromatography to compare the pigments of different algae.

Devise an experiment to show the variation of a rate constant on temperature.

Determine the acceleration due to gravity using a pendulum.

Work out the resonant frequency of the Tacoma Narrows bridge from the well-known film of its collapse.

1.2 Make predictions directly related to a research question.

Predict and test the action of auxin on plants.

Predict the outcomes of dihybrid crosses and compare the predictions with collected data.

Make and test predictions concerning the characteristics of animal groups.

Predict the characteristic properties of an element (e.g. tin or nickel) from its position in the periodic table and suggest ways to test some of the predictions.

Test the prediction that anodising a sample of aluminium increases its resistance to corrosion.

Predict the effect of adding a given small quantity of concentrated hydrochloric acid to a saturated solution of lead chloride. Test the prediction.

1.3 Identify and control variables.

Identify and control variables when measuring transpiration of plants.

Design an experiment to test a new drug to protect against malaria.

Compare the behaviour of different materials under stress.

1.4 Work constructively and adaptively with others as a team on a scientific investigation.

Work as a team to map the plant succession on a rocky seashore.

Collectively research the incidence of cholera in selected countries.

Prepare a booklet on the animals of Qatar.

1.5 Evaluate experimental design, identify weaknesses and develop realistic strategies for improvement.

Develop an appropriate way to determine the wavelength of light absorbed by chlorophyll.

Design a study to determine the impact of creating a conservation area in Qatar.

Identify the most significant areas of uncertainty in the determination of Young’s modulus for a variety of materials, and devise strategies to address them.

1.6 Work in an ethical manner with regard to acknowledging data sources and authenticity of results.

Prepare information sheets about the major diseases of the world.

Script a radio play about the lifestyle of a diabetic who uses insulin.

Draw pie charts of blood composition.

Make a collection of photographs of xerophytic adaptations of plants.

Acknowledge the use of illustrations of different kinds of stars and galaxies downloaded from the Internet.

1.7 Work in an ethical manner with regard to living things and the environment.

Take appropriate measures to limit disturbance to wildlife and habitats when engaged in field work.

Behave responsibly when working with peers to measure human traits such as skin sensitivity, sight, hearing.

1.8 Identify, and make critical use of, secondary information.

Use WHO data to draw maps of the incidence of malaria.

Use census data to plot population growth curves.

Study and assess information on the Internet related to climate change.

Study and assess information on the Internet related to the ‘ozone hole’ and the effectiveness of international agreements to combat it.

#### 2 Know how scientists work

2.1 Understand the historical development of major scientific ideas.

Find out about the development of genetic fingerprinting.

Track the evolution in our in understanding of HIV/AIDS.

See standard groups 34 and 35

Study the evolution of our understanding of the Universe (noting particularly the seminal role of Islamic philosophers in developing the concept of the heliocentric Solar System).

Study the evolution of our ideas about the nature of light.

2.2 Know how scientific work is affected by its economic, social, cultural, moral and spiritual contexts.

Discuss the cultural and moral constraints placed by societies on research on genetic manipulation, cloning and stem cells.

Collect press information that debates the arguments for and against child vaccination.

2.3 Show an understanding of the power and limitations of science in addressing industrial, social and environmental questions.

Review the evidence that science has provided the knowledge needed to breed plant and animals that could feed the world and consider why people starve.

Find out which plant and animal species are in danger of extinction and what, if any, steps are being taken to halt their decline.

Debate the reasons for fishing in areas where the fish population is in decline.

2.4 Understand the importance of refutation in the replacement of a prevailing scientific paradigm with a new one.

Note the examples of the photoelectric effect, which appeared to refute traditional theories relating to energy prevailing in 1900 but could be explained by the quantum theory, and of the Rutherford scattering experiment, which overturned the idea of atoms as solid particles.

See Standard 30.2

2.5 Recognise that the development of scientific ideas often proceeds in periods of major changes followed by periods of slow elaboration.

Identify major changes in the history of science (e.g. the heliocentric Universe of the early Islamic philosophers, Newtonian mechanics, the development of our understanding of atomic structure, the development of the science of thermodynamics, the development of quantum theory).

2.6 Appreciate the significance of the development of probabilistic foundations of our understanding of natural phenomena.

Discuss the apparent contradiction between the probabilistic, random nature of the fundamental matter of which the Universe is built and the determinist teachings of major world religions.

#### 3 Process and communicate information

3.1 Record raw data appropriately in a manner that allows easy interpretation.

Sketch the position of the solvent front and pigment positions from chromatograms.

Draw tables of the phenotypes of genetic crosses.

3.2 Process raw data by the most appropriate means.

Draw maps to show the incidence of major diseases.

Graph population statistics over time.

3.3 Draw valid conclusions, allowing for errors and uncertainties.

Calculate the probability of obtaining the progeny of genetic crosses by chance.

Use a graphical method for determining g using a pendulum that allows errors to be spotted and eliminated.

3.4 Use an appropriate range of methods to communicate scientific information.

Use charts to illustrate metabolic pathways.

ICT opportunity

Prepare a PowerPoint presentation.

Prepare a PowerPoint presentation on monoclonal antibodies.

Use models to illustrate the action of antibodies.

Use applets to illustrate a variety of three-dimensional physical processes.

#### 4 Handle equipment and make measurements

4.1 Select and use correctly and competently the appropriate equipment and materials for an investigation, with due regard for the safety of self and others.

Use chromatography to separate plant pigments.

Use blood group identification cards.

Work with a DNA testing kit.

Use a xenon stroboscope to determine the frequency of a vibration.

Use a laser and a microwave generator to show interference.

Use a spectroscope to study emission and absorption spectra.

4.2 Follow instructions accurately but be able to adapt to unforeseen circumstances.

For Grade 12 advanced level, the weightings of the assessment objectives to be applied to each content strand are as follows:

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| --- | --- | --- | --- |
|  | Knowledge and understanding | Application, analysis and evaluation | Scientific enquiry skills and procedures |
| Assessment weighting | 45 to 55% | 25 to 35% | 20 to 25% |